Biologic and Resource Analog Investigations in Low Light Environments (BRAILLE)

Completed Technology Project (2017 - 2020)

Project Introduction

Lava tube caves offer protection from surface hazards and may be among the few human- or robot- accessible locations on other planets that could preserve evidence of microbial life. On Earth, they yield access to the subsurface and are natural settings where biology is protected from environmental extremes (surface radiation, thermal variations), geologic history is exposed and preserved, and subsurface resources (H2O, liquid and solid) may be accessible. It is an austere environment for microbial life, with dramatic changes in light moving inward from the cave entrance. We will conduct terrestrial field campaigns in which we compare ground-truth data collected from the cave environments with measurements conducted using a rover science platform. These activities will be combined with input from a remotely located mission team, who will process operational and scientific data collected by the rover and its payload. This will provide us with the opportunity to test the performance and capabilities of the robotic system under operational conditions and conduct fundamental research on cave astrobiology. Science Goals and Objectives: Our key science questions concern how abundance and diversity of microbial communities are affected by lava tube ecology, particularly in transition from ambient daylight to aphotic conditions, and whether biological signatures can be detected remotely on cave walls and floors. We propose to investigate and document the geologic and biological variability in a natural lava tube and the impact on science operations and capabilities that occurs while operating a rover in low light environments. Exploration and characterization of lava tubes is challenging due to their inherently low-light levels and potential obstacles in 3 dimensions. Methodology: We will undertake operations in two low light environments, one in the field at Lava Beds National Monument in N California and another at NASA Ames. In the operation involving the lava tube, we will use a rover to explore the site. The chief rover scientific instruments will be a spectral imaging camera fitted with selected wavelength filters optimized for identification of morphological and compositional variations and an environmental sensor unit to document temperature, light, and humidity in the local environment moving away from the cave entrance. Additionally, members of the field team will collect samples for subsequent analyses to characterize the microbiology and mineralogy as a function of distance in the LT. Our operations at Ames will involve a control group exploring a test bed area with normal illumination and a sample group operating only with low-light illumination. In the simulation involving the lava tube, both the control and sample groups will have the same time to explore the site and their impressions/interpretations will be compared. Relevance: Our proposed effort will address all three objectives relevant to PSTAR: science, science operations, and technology (Section 1). From a planetary science perspective, geologic and biologic activities are observable in natural lava tubes, making them relevant to scientific exploration of other planets. Lava tubes are also regions of resource potential. Our systems-level terrestrial field campaigns will approximate operations during a planetary mission, providing an opportunity

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Planetary Science and Technology Through Analog Research

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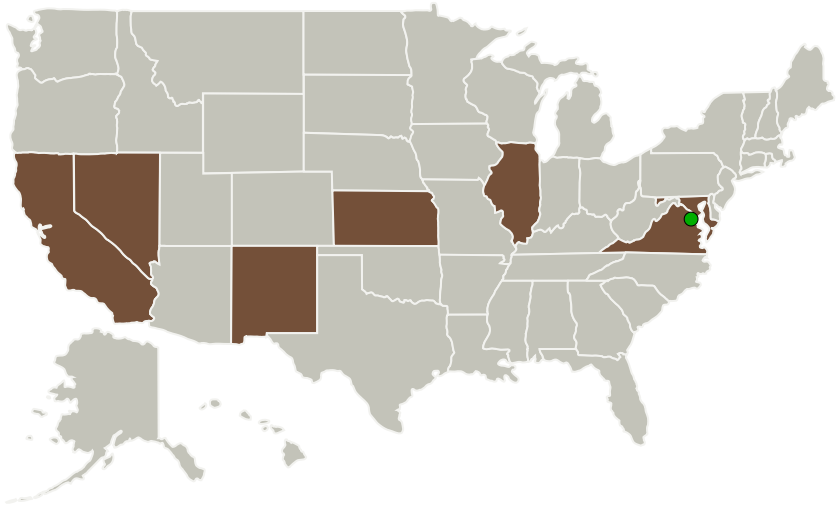
to assess performance, capabilities, and efficiencies of science operations in lava tubes and, by involving human participants, lead to new concepts of operations in low light environments (such as lunar poles or asteroids) in general. Our proposed effort will address the technology application through use of uv light sources for spectral imaging, permitting assessment of uv sources for identifying potential biological and hydrated mineralogical markers. Our sampling and subsequent analyses will provide additional assessment of the techniques used during the rover exploration.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
NASA Headquarters(HQ)	Supporting Organization	NASA Center	Washington, District of Columbia

Primary U.S. Work Locations	
California	Illinois
Kansas	Maryland

Continued on following page.

Project Management

Program Director:

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Program Manager:

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Saugata Datta
Carol R Stoker
Richard J Leveille
Ted L Roush
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Mathew C Deans
Uland Y Wong

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.2 Mobility
    - TX04.2.1 Below-Surface Mobility

Target Destination

Others Inside the Solar System

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Primary U.S. Work Locations *(cont.)*	
Nevada	New Mexico
Virginia	